Towards Ethical Software Development:

Safeguarding Users in the Mobile Age

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Introduction:

The introduction of mobile technology marks a defining point in history and has played a transformative role in shaping our modern society. Instant communication has reshaped many industries leaving a lasting mark on agriculture, commerce, and manufacturing. Global markets have blossomed, expanding into interconnected webs that receive instant updates from corners of the globe in real time. Amidst these advancements, however, the growing concern of unhealthy mobile phone use and addiction looms. Mobile phone addiction, an affliction mirroring behavioral patterns associated with pathological gamblers and substance addicts, has emerged as a pressing societal issue. Research by Bianchi and Philips (2005) has found concerning behaviors among phone addicts including the concealment of their usage from family and friends, financial harm as a result of excessive use, and an impending sense of preoccupation, anxiety, and depression when without the company of their phone. Furthermore, these individuals often use the devices as an escape from reality, along with the challenges and emergencies of life.

This affliction, when traced back to its roots, reveals a complex relationship between personality traits, human emotion, and the deceptive psychology developers employ. Examples of inherent human traits that make a person vulnerable to such afflictions include shyness and loneliness. As studied by Bian and Leung (2015) these traits can make a person predisposed to psychology designed to exploit these very traits. These very devices that initially were designed to bridge our communication gap inadvertently offer and escape, allowing individuals to avoid the accountability associated with face-to-face interactions. Even more, the instant connectivity provided results in more extreme levels of these feelings when the availability of that connectivity is withdrawn (Orlowski 2020). Despite the allure and usefulness of constant connectivity, it is important to recognize the implications of these dependencies.

These define the line between mobile technology acting as a tool that can aid us through our lives and acting as an escape and reality that leads to dependence. Unfortunately, these psychological impacts are just the symptoms of the problem. Because of the competition for user engagement, modern developers are faced with economic incentives to employ features designed to exploit inherent human traits.

This paper aims to answer the question, to what extent have these methods become entrenched in software development and how has mobile technology rooted its afflictions in society? The research intends to reveal the underlying causes of this modern issue and offer guidance for modern software development that fails to encompass the issues of modern technology. The issue of user behavior is not an emphasis of modern platforms, differing from traditional values in engineering that hold the consumer safety paramount. Experimental technology is not viewed as such when released and fails include values of user autonomy and informed consent that other disciplines emphasize. On the other hand, there are some technological initiatives that have come about aimed at combatting these features and returning agency to the user. This research delves into where the industry strayed and offers a look into what solutions moving forward might be.

Background and Context:

This investigation into the deceptive influence of modern technology requires an understanding of the sociotechnical situation that has facilitated its development. Rooted in the framework of mutual shaping, my research explores the intricate relationship between mobile technology and society, focusing on how the demands of one affect the advancements of the other and vice versa. Mobile technology is not a neutral tool, it is shaped by societies demands

and reflects the mutual shaping relationship where in society and technology influence each other reciprocally. Lying in this relationship is the key to understanding the underlying trends that have led us to current situations. This provides an understanding of how society may view these issues as problematic but the demand for further advancement can still prevail. Rooted in mutual shaping, mobile technology reflects the influence of society but even further, influences society through the capabilities it provides. Regulating and ensuring this influence is to our benefit and should of great importance to us, and to do so, appropriate guiding principles must be in place.

To further analyze the existing applications and guidelines for the modern developer, consider the ethical frameworks in place that the modern developer must meet. Primarily there are guidelines established by companies that sponsor platforms such as the app store. An example of this would be Apple that has a guiding principle of "we want to provide a safe experience for users to get apps and a great opportunity for all developers to be successful" (Apple Review Guidelines, n.p.). They also emphasize that apps reach all audiences and to keep the youth in mind when distributing apps. In terms of concerns for user safety, these two statements encompass their values but fail to explicitly define the standards to which apps should be held. This is not to say that Apple is to blame but that there is a failure in the industry to consider user safety and behavior beyond engagement. In a similar tangent, consider the google play store and values it emphasizes. Again, there is a point about the youth in that apps that reach children should be considerate of this and abide by relevant laws. It also requires that applications comply with the monetization policies of the play store which allow for in-app purchases and ad-based models. In terms of user safety, this is all it covers. There is a general lack of updated ethical frameworks and guidelines for developers to follow (Google Play

Guidelines). There are professional codes for computer scientists and computer engineers to follow as well but they emphasize a broad range of topics and due to their general vagueness in principles, fail to serve as guidelines for modern, mobile tech and software development.

Beyond the theoretical framework and due to a lack of it, mobile apps employ a myriad of features such as infinite scrolling, variable rewards, and the illusion of choice, designed to create psychological draws that prolong use.
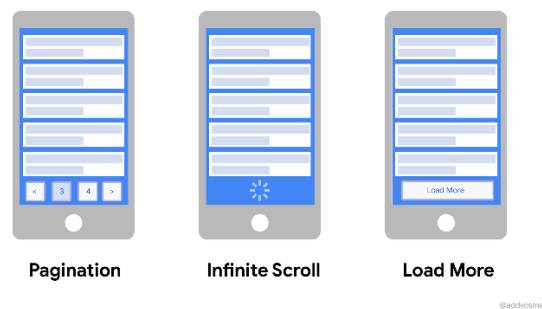

Figure 1 – Infinite Scroll vs. Traditional methods

As pictured in Figure 1, infinite scroll differs from traditional methods that provide the user with a decision to see more content. These other options provide the user with a button to press that requires them to decide if they want more content or not. Infinite Scroll, on the other hand, combines with algorithms and user data to provide seamless sequential content that is truly endless. This is comparable with a bottomless bowl study conducted by a Cornell professor in 2005, a study in which users consumed 75 percent more soup when exposed to unlimited soup versus a set portion (Chauncey 2017). Infinite scrolling exploits innate human tendencies, keeping users engaged beyond their original intent. Even further, the use of features like excessive and patterned notifications exemplifies a deliberate ploy to manipulate user behavior

(Xiaowei et al 2023). Features like these exemplify some of the ways user data is leveraged against the user, highlighting mobile technology's failure to prioritize society's best interests.

Methods:

My research has focused on secondary literature as evidence for a collection and review of the current situation in the technology industry. To start, I selected reputable databases including google scholar and university libraries. I then used key words and search filters to find relevant and encompassing literature. I then have several criteria I look at within an article to assess its value holistically. These criteria include the publication date, author qualifications, sources referenced, and goal or purpose of the study. By evaluating the articles under these criteria, I find fact-based evidence presented with genuine intentions towards a quality argument. I then categorize content by relevant themes that emerge from the literature. I also look for primary source evidence such as testimony from employees or former employees of the industry that offer some insight into the product development process and intentions of developers. With this thorough gathering and analysis of evidence I cite credible encompassing sources that capture the true scope of the mobile industry.

Results:

The dilemma faced in the industry is that success depends on users and the large competition for users results in the current situation where a company must employ all features and strategies or get left behind. As former designers and executives put it, the true product these companies are selling is an individual's time (Orlowski 2020). Mobile technology is a gateway to software designed to maximize user engagement and make money off this engagement through advertising. Noting that, it is clear that the hardware developers are not directly

responsible for the deceptive traits of this software, but the devices certainly aren't designed to prevent them. But to move towards a solution it is imperative that this issue starts getting addressed at all levels. As of 2017 almost 77 percent of Americans own smartphones and it's their prominence that makes their usage so compelling (Cha and Seo 2018). Such dependency on phones ties them to our lives, requiring their usage. It is clear that cellular technology makes our lives easier but the constant state they hold in our lives opens the door for exposure to the bad side, the engagement and advertising industry. Over engagement with these aspects of cellular technology leads to the physical and psychological effects and ultimately, mobile addiction. These effects such as sleep deficit, anxiety, and even depression even more harshly affect youth and turns what could be considered a habit, into an obligation (McNutt 2019). As previously mentioned, not every aspect of mobile technology is responsible for these adverse effects but just certain activities that push users across the tipping point towards addiction.

One of the primary features that yields addictive behavior is the desire to connect socially. A study of college students found this to be a driving factor in cell phone addiction though the specific applications responsible varied between sexes (Roberts 2015). Common behaviors on a phone can yield both positive and negative reinforcement. Examples of positive reinforcement include experiencing feelings of happiness such as when your friend sends a video or a message is received. Negative reinforcement on the other hand involves behaviors such as taking a call or checking an email to avoid a social situation. This is when the technology becomes problematic in that the convenience and ease with which it can be employed turns habitual. When it comes to gender it certainly seems that women are more susceptible even tracing back to landline phones which men used more as a tool, to plan or procure, while women

would use to connect socially (Aberu et al 2022). This is not lost on developers that create software to prey on both of these tendencies.

The mobile technology applies this social aspect and in studying college students it was found that women see mobile technology as a tool of communication to maintain and nurture relationships while their male counterparts see the same mobile technologies as sources of entertainment. It is likely because of this that females exhibit more attachment to their phones due to their heightened social importance. Findings suggest that a user's time on social media like Instagram and Facebook are good indicators of potential addiction (Roberts 2015). This is not to say males are exempt from the issue as entertainment platforms can be just as compelling and habitual. The addiction faced by men stems from applications more like twitter or mobile gaming that provide braindead content and information on topics such as sports or other news. These apps then use notifications to reinforce their prominence in a users life. Activities involving lifestyle applications were found to have less correlation to cell-phone addiction as they exhibited more utilitarian uses that are not as addictive in nature compared to the entertainment and social aspects.

Noting these features and tendencies, specific guidelines that should be implemented became clear. An updated framework for app development is all the more imperative. Due to the modernity of the issue there is no accepted code of ethics tailored to mobile applications that emphasize user behavior. Several professional organizations within the technology industry have codes of ethics and conduct relevant to technological development but these are broad and do not encompass recent trends. Research has proposed that the introduction of technology could benefit from being viewed more experimentally, similar to other fields that consider humans as test subjects (Martin and Schinzinger 1983). This calls for a more cautious approach to be taken

with the introduction of experimental technology "because even if all reasonable efforts to anticipate social consequences haven been undertaken, it is possible, and even likely that there will be unanticipated social consequences" (Van de Poel, 2015). Viewing the users as test subjects would emphasize the need for principles of informed consent and safety that other fields like research and medicine already have in place. With informed consent and greater autonomy people tend to have larger concerns about technology. Since the goal of informed consent is to respect people's concerns, developers must consider these bigger concerns when it comes to their product (Asveld, 2006). By applying the principles of these codes and considering the consequences of mobile technologies, a code of ethics established for mobile design should hold the following paramount. An updated framework for development should include points comparable to the following:

User-Centric Design

- The needs, preferences, and safety of the users throughout the design process is a priority.
- User well-being and safety should be central considerations in making product decisions.

Transparency and Informed Consent

- The user has access to clear and transparent information about data collection and data sharing.
- Minimizing the collection and retention of personal data to only what is necessary for functionality and securing the data that is collected is paramount.
- The user has accessible and manageable privacy settings.

Algorithmic Transparency and Accountability

- Applications that use algorithms or machine learning must be monitored for
  accountability and bias.

- Recognize that implementation of these models results in unintended consequences that
  may influence user behavior.

Safety and Harm Mitigation

- Applications must avoid manipulative design techniques or dark patters that exploit the
  vulnerabilities of the user.

- Implement safeguards such as content moderation and age-appropriate restrictions to
  protect vulnerable users such as children.

Leadership and Accountability

- Emphasize ethical considerations to design teams and engage with relevant stakeholders
  such as the users throughout the design process.

- Foster open dialogue and transparency and hold team members accountable for
  upholding ethical standards in their work.

Establishing a framework for development of software, one the pertains specifically to
mobile applications would aid developers in ensuring their software is considerate of the
user. In fields like medicine where human health is the priority, these principles are naturally
established. This is different for technological practice, where engineers aim to serve goals
that they do not define by themselves, such goals are defined in communication with clients
and regulatory instances that serve to protect the interest of the public at large (Asveld,
2006). These goals often do not prompt the necessary questions that must be asked about a

user's behavior and safety. Current trends in the tech industry to not prioritize the user's behavior past engagement. What once may have been unintended consequences of this lack of consideration, are now being overlooked in the industry as the competition for user engagement holds priority. This competition has resulted in the employment of features that impact user behavior beyond the extent of interfacing with applications.

There are some initiatives that have come about as technological solutions to the issue of mobile addiction. Primarily, developers have built in time limits that users can set on apps as an attempt at self-regulation or parental regulation. The effectiveness of these time limits is minimal without the accountability of having another person responsible for unlocking it. Another solution that has come about is the Brick.

Figure 2 – The Brick (taken from getbrick.app)

Pictured above, the Brick provides a more tangible physical element as part of its effort to be more effective. The Brick is a physical key to your applications that interacts with your phone similar to NFC chips through touch. When touched initially at the start of your distraction free time, it locks the applications you have selected. You then leave the key

behind as you go for your walk or to the library and the temptation to engage with these apps is no longer present because without the Brick to touch and unlock them, you are unable to. This is an improvement from self-regulation such as the time limit which still provides you with the constant temptation and required decision with every bump and nudge your phone provides (Brick 2023).
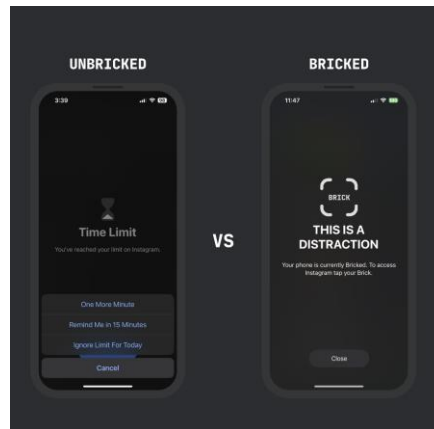

Figure 3 – The Brick vs. Time Limit (taken from getbrick.app)

This is a relatively new initiative however, launched in the Fall of 2023 and while the theory is present, its effectiveness is still being evaluated. The physical object reduces the cognitive load on the individual making it less likely for a user to impulsively unblock apps. The physical action this product requires emphasizes a deliberate step and values of intentionality that aim to improve the user's commitment ability. It will be interesting to see how other initiatives build off this idea and what other technological solutions to this technological problem will arise.

Conclusion

To effectively govern software development and mitigate the deceptive practices within mobile technology, it is imperative to establish a comprehensive framework that addresses user behavior concerns. While existing platforms and professional societies acknowledge user safety, they often fall short in addressing the extent and capabilities to which mobile technology can influence. These frameworks are outdated, failing to encompass modern technology, and consequently, contribute to a lack of awareness regarding user safety within the industry. The awareness of the significant influence software holds over users is only a recent trend. In other fields that are recognized as experimental, this concern is held paramount. Deceptive features such as infinite scroll and targeted algorithms serve as root causes behind mobile addiction, demonstrating the importance of addressing these issues at the development stage. Viewing users and technology as experimental naturally leads to interworking the concepts of informed consent and user safety as this technology is released. This would help govern concerns and decisions in the development stage as well. This is paramount towards returning mobile technology to a tool to be used for society's benefit as opposed to a convenient escape that leaves users distracted and out of touch.

Future research should delve into the evolving trends in technology and examine how user behavior is prioritized in software design and development. Continuous evaluation of user safety and behavior is essential to ensure that implemented software does not negatively affect its users. Developers and application platforms, including the App store and Google Play Store, must strive to incorporate more specific frameworks to guide accessible applications. This

concerted effort could potentially lead to a shift in the intentions behind applications and software, fostering a safer environment for users.

Additionally, exploring technological solutions like the Brick and monitoring their effectiveness is crucial in redirecting mobile technology toward serving societal needs. While initiatives like The Brick are promising, there remains a scarcity of similar efforts. The Brick aims to improve discipline and commitment in one's relationship with technology. It promotes autonomy and empowers users to take control of their technology use. It represents an innovative approach towards solving the digital distraction that mobile technology creates and in doing so, leads the field in a just cause. Moving forward, it is vital to assess the effectiveness of such solutions, including enhanced self-monitoring capabilities, and continually innovate and adapt to address emerging challenges and improve these solutions as technology progresses.

As awareness of the adverse effects of mobile technology becomes more widespread, it is imperative to take proactive measures to mitigate its negative impacts. By prioritizing user safety, fostering ethical software development practices, and embracing innovative solutions, we can steer mobile technology towards becoming a tool and facilitator in society as opposed to an addiction that slowly cripples many. This research serves as a foundation for further exploration and action in creating a more responsible and user-centric digital landscape.

References

Abreu, Carlos, and Pedro F. Campos. 2022. "Raising Awareness of Smartphone Overuse among

University Students: A Persuasive Systems Approach" Informatics 9, no. 1: 15.

https://doi.org/10.3390/informatics9010015

Apple Inc. (2024, April 5). *App Review guidelines*. Apple Developer.

https://developer.apple.com/app-store/review/guidelines/

Asveld, L. (2006). Informed consent in fields of medical and technological practice: An

explorative comparison. Techné: Research in Philosophy and Technology, 10(1), 17-30.

https://www.pdcnet.org/8525763B0050E6F8/file/08D1F14D237D238F8525772300497D

93/$FILE/techne_2006_0010_0001_0017_0030.pdf

Bianchi A., Phillips J. (2005). Psychological predictors of problem mobile phone use.

CyberPsychology & Behavior, 8, 39–51. doi:10.1089/cpb.2005.8.39

Bian, M., & Leung, L. (2015). Linking Loneliness, Shyness, Smartphone Addiction

Symptoms, and Patterns of Smartphone Use to Social Capital. Social Science Computer

Review, 33(1), 61 79. https://doi.org/10.1177/0894439314528779

Cha SS, Seo BK. Smartphone use and smartphone addiction in middle school students in Korea:

Prevalence, social networking service, and game use. Health Psychol Open. 2018 Feb

2;5(1):2055102918755046. doi: 10.1177/2055102918755046. PMID: 29435355;

PMCID: PMC5802650. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5802650/

Chauncey Neyman. 2017. A Survey of Addictive Software Design. 1, 1, Article 1 (June 2017)

Shoukat S. Cell phone addiction and psychological and physiological health in

adolescents. EXCLIJ. 2019 Feb 4;18:47-50. PMID: 30956638; PMCID: PMC6449671.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6449671/

Developer policy center. *Developer Policy Center*. (2024, April).

https://play.google/developer-content-policy/

Martin, D.A. (2019). The Ethics of Engineering. RTE Brainstorm, made available Monday, 2nd

December 2019, 09.48. doi:10.21427/nx13-nc31

Orlowski, Jeff (September 9, 2020), The Social Dilemma (Documentary, Drama), Tristan Harris,

Jeff Seibert, Bailey Richardson, Joe Toscano, Exposure Labs, Argent Pictures, The Space

Program, retrieved March 2020.

Roberts, J. A., Petnji Yaya, L. H., & Manolis, C. (2015). The invisible addiction: Cell-phone

activities and addiction among male and female college students. Journal of Behavioral

Addictions, 3(4), 254. https://doi.org/10.1556/2006.3.2014.085

Van de Poel, I. An Ethical Framework for Evaluating Experimental Technology. Sci Eng Ethics

22, 667–686 (2016). https://doi.org/10.1007/s11948-015-9724-3

Your phone, minus the distractions. Brick. (2023). https://getbrick.app/

Xiaowei Chen, Anders Hedman, Verena Distler, Vincent Koenig, Do persuasive designs make

smartphones more addictive? - A mixed-methods study on Chinese university students,

Computers in Human Behavior Reports, Volume 10, 2023, 100299, ISSN 2451-9588,

https://doi.org/10.1016/j.chbr.2023.100299.